Name: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Period: \_\_\_\_\_\_\_ Date: \_\_\_\_\_\_\_\_\_\_\_\_\_

**Copper Sulfate Hydrate Lab**

Background Information

**Hydrate**: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

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Examples:

* Na2SO4H2O
* MgSO47H2O
* LiClO43H2O
* MgCO35H2O

**Dehydration**: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

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**Anhydrate**: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

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**Copper (II) Sulfate Background Information:**

“Copper sulfate is a fungicide\* used to control bacterial and fungal diseases of fruit, vegetable, nut and field crops. Some of the diseases that are controlled by this fungicide include mildew, leaf spots, blights and apple scab. It is used in combination with lime and water as a protective fungicide, referred to as Bordeaux mixture, for leaf application and seed treatment. It is also used as an algaecide, an herbicide in irrigation and municipal water treatment systems, and as a molluscicide, a chemical used to repel and kill slugs and snails. Copper sulfate is a naturally-occurring inorganic salt and copper is an essential trace element in plant and animal nutrition.” [*http://pmep.cce.cornell.edu/profiles/extoxnet/carbaryl-dicrotophos/copper-sulfate-ext.html*](http://pmep.cce.cornell.edu/profiles/extoxnet/carbaryl-dicrotophos/copper-sulfate-ext.html)

\*Fungicide: chemical that kills fungus

**Hydrate Background Information:**

Some solids contain a certain number of water molecules as part of their chemical structure. Salts that contain water as part of their structure are called hydrates. When this water is removed from the hydrate, the salt that remains is called an anhydrate.

*(Adapted from* [*http://www.chalkbored.com/lessons/chemistry-11/hydrate-lab.pdf*](http://www.chalkbored.com/lessons/chemistry-11/hydrate-lab.pdf)*)*

**Purpose**: The purpose of this experiment is to determine the empirical formula of Copper sulfate hydrate.

In this experiment, you will remove the water from a known mass of copper sulfate hydrate by heating the compound in an evaporating dish:

heat

CuSO4 \_\_\_\_H2O CuSO4 + \_\_\_\_H2O

copper sulfate hydrate copper sulfate (anhydrate) water

**Pre-Lab Questions**

*Some of these questions will require you to look at the procedure toward the end of the packet. Answer in complete sentences.*

1. Define the following two terms.
   1. Percent composition
   2. Empirical formula
2. What is the formula for determining percent composition?
3. Calculate the percent composition of H2O in MgSO47H2O.
4. What is the empirical formula of a compound that is 25.9% nitrogen and 74.1% oxygen?
5. What happens to the copper sulfate hydrate as it is heated? Don’t just mention the color change. (Look at the chemical reaction on page 1.)
6. Why are we heating the copper sulfate hydrate? How will that help us figure out its empirical formula?
7. Sara, Perrin, and Simone perform the lab with magnesium carbonate hydrate instead of copper sulfate hydrate. They collect the following data:

|  |  |
| --- | --- |
| **BEFORE HEATING** | |
| **1. Mass of evaporating dish** | 45.3 grams |
| **2. Mass of evaporating dish + MgCO3 hydrate** | 48.3 grams |
| **3. Mass of ONLY MgCO3 hydrate** |  |
| **AFTER HEATING** | |
| **4. Mass of evaporating dish + MgCO3 anhydrate** | 46.725 grams |
| **5. Mass of ONLY MgCO3 anhydrate** |  |
| **6. Mass of ONLY H2O** |  |

* 1. Calculate the percent composition of H2O in MgCO3 hydrate based on Sara, Perrin, and Simone’s data.

* 1. The actual percent composition of water in magnesium carbonate hydrate is 51.66%. What was their percent error?
  2. According to the group’s data, how many moles of H2O are there for each 1 mole of MgCO3? Answer this question by filling in the table below.

|  |  |  |
| --- | --- | --- |
| STEPS: | MgCO3 | H2O |
| 1. Write the mass of each compound | 1.425 grams MgCO3 | 1.575 grams H2O |
| 2. Convert from MASS to MOLES |  |  |
| 3. Divide both numbers by the smallest number of moles |  |  |

For every 1 mole of MgCO3, there are \_\_\_\_\_\_\_\_\_\_\_\_\_ moles of H2O.

* 1. The actual percent composition of MgCO3 hydrate is 48.34% MgCO3 and 51.66% H2O. Based on these numbers, what is the empirical formula of MgCO3 hydrate?

|  |  |  |
| --- | --- | --- |
| STEPS: | 48.34% MgCO3 | 51.66% H2O |
| 1. Convert from PERCENT to MASS |  |  |
| 2. Convert from MASS to MOLES |  |  |
| 3. Divide both numbers by the smallest number of moles |  |  |
| 4. Multiply both numbers by the same number so that they’re whole |  |  |
| 5. Write the empirical formula | MgCO3 \_\_\_\_H2O | |

**Purpose**: The purpose of this experiment is to determine the empirical formula of Copper sulfate hydrate. In this experiment, you will remove the water from a known mass of copper sulfate hydrate by heating the compound in an evaporating dish:

heat

CuSO4 \_\_\_\_H2O CuSO4 + \_\_\_\_H2O

copper sulfate hydrate copper sulfate (anhydrate) water

**Safety**

* Wear goggles while handling copper sulfate
* Keep a safe distance from hydrate when heating
* Copper sulfate is toxic: rinse affected areas with lots of water
* Clean up all spills immediately
* Wash hands after performing the lab

**Materials and Methods**

* Goggles
* Evaporating dish
* Wire mesh
* Tongs
* Scoopula
* Electronic or triple beam balance
* Weigh dish
* 2-4 grams of Copper sulfate hydrate
* Hot plate
* Stopwatch

**Copper Sulfate Hydrate Lab Procedure**

1. Use a balance to find the mass of the evaporating dish. Record the mass in your data table.
2. Put on your goggles.
3. With the evaporating dish on the balance, pour the copper sulfate hydrate from your weigh dish to the evaporating dish. Record the mass of the copper sulfate hydrate + evaporating dish.
4. Carefully carry the evaporating dish to your desk. Record your first observations in your observation table (time = 0 minutes).
5. Start heating the dish on the lowest setting. Start your stopwatch as soon as you place the evaporating dish on the hot plate.
6. Increase the heat slightly every 60 seconds until the heat is at 90% power. If any popping or splattering occurs, decrease the amount of heat on your evaporating dish. *BEWARE that the hot plate turns off every couple of minutes- make sure to keep turning it back on.*
7. **Record observations every 3 minutes.**
8. Continue to heat at 90% power for 10-15 minutes. The copper sulfate hydrate will gradually change from a blue to white color. During the heating, use your scoopula to mix the compound or break up clumps. Be careful not to remove any of the compound.
9. Once all the blue color is gone, remove your evaporating dish from the hot plate using your tongs. Place it on the wire mesh. Stop your stopwatch and record the time on this line: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.
10. Allow the evaporating dish to cool for one minute, then record the mass of the dish + copper sulfate below.

**Data Table**

|  |  |
| --- | --- |
| **BEFORE HEATING** | |
| **1. Mass of evaporating dish** |  |
| **2. Mass of evaporating dish + CuSO4 hydrate** |  |
| **3. Mass of ONLY CuSO4 hydrate** |  |
| **AFTER HEATING** | |
| **4. Mass of evaporating dish + CuSO4 anhydrate** |  |
| **5. Mass of ONLY CuSO4 anhydrate** |  |
| **6. Mass of ONLY H2O** |  |

**Observations**

|  |  |
| --- | --- |
| **Time** | **Observations** |
| 0 minutes |  |
| 3 minutes |  |
| 6 minutes |  |
| 9 minutes |  |
| 12 minutes |  |
| 15 minutes |  |
| Final Observations |  |

**Post-Lab Calculations**

1. Calculate the percent composition of H2O in CuSO4 hydrate based on your data.

2. The actual percent composition of water in copper sulfate hydrate is 36.08%. What was your percent error?

3. According to your data, how many moles of H2O are there for each 1 mole of CuSO4? Answer this question by filling in the table below.

|  |  |  |
| --- | --- | --- |
| STEPS: | CuSO4 | H2O |
| 1. Write the mass of each compound |  |  |
| 2. Convert from MASS to MOLES |  |  |
| 3. Divide both numbers by the smallest number of moles |  |  |

For every 1 mole of CuSO4, there are \_\_\_\_\_\_\_\_\_\_\_\_\_ moles of H2O.

4. The actual percent composition of CuSO4 hydrate is 63.92% CuSO4 and 36.08% H2O. Based on these numbers, what is the empirical formula of CuSO4 hydrate?

|  |  |  |
| --- | --- | --- |
| STEPS: | 63.92% CuSO4 | 36.08% H2O |
| 1. Convert from PERCENT to MASS |  |  |
| 2. Convert from MASS to MOLES |  |  |
| 3. Divide both numbers by the smallest number of moles |  |  |
| 4. Multiply both numbers by the same number so that they’re whole |  |  |
| 5. Write the empirical formula | CuSO4 \_\_\_\_H2O | |